Blood pressure during pregnancy in Canadian Inuit: community differences related to diet

Dianne Popeski,* MSc (Med), MD; Lori R. Ebbeling,* MSc, MD; Patrick B. Brown,‡ MD; Gerard Hornstra,† PhD; Jon M. Gerrard,* MD, PhD

Objective: To assess a possible relation between the incidence of hypertension during pregnancy and the consumption of fatty acids found in fish and sea mammals.
Design: Retrospective survey of pregnancy-induced hypertension; prospective diet survey.
Setting: Inuit women from seven communities in the Keewatin region of the Northwest Territories.
Patients: All women from Arviat (formerly Eskimo Point), Baker Lake, Chesterfield Inlet, Coral Harbour, Repulse Bay, Sanikiluaq and Whale Cove who gave birth between Sept. 1, 1984, and Aug. 31, 1987.
Main outcome measures: All blood pressure measurements recorded during the pregnancy, incidence of pregnancy-induced hypertension in the seven communities, harvest of country food (food obtained from the land or sea rather than bought in a store) for six of the communities, self-reported consumption of fish, sea mammals and terrestrial mammals by a subgroup of the subjects and levels of phospholipid fatty acids in cord serum samples from a subgroup of the infants.
Main results: Significantly lower mean diastolic blood pressure values during the last 6 hours of pregnancy were noted for the women from the three communities with a higher consumption of fish and sea mammals (78.2 [95% confidence limits (CL) 76.6 and 79.9] mm Hg) than for those from the four communities with a lower consumption of such food (81.5 [95% CL 80.1 and 82.9] mm Hg) ($p < 0.005$). The relation between community diet type and blood pressure was independent of other factors. Correspondingly, the women from communities with a lower consumption of marine food were 2.6 times more likely to be hypertensive during the pregnancy than those from communities with a higher consumption of marine food ($p < 0.007$). Parity ($p < 0.05$) and prepregnancy weight ($p < 0.005$) were also significantly associated with pregnancy-induced hypertension; however, the relation between hypertension and community diet type remained significant in logistic regression analysis (odds ratio 2.56, $p = 0.03$). The differences between the community groups were substantiated by the results of the diet survey, the levels of eicosapentaenoic acid (EPA) in the cord serum phospholipids and the harvest data.
Conclusions: Increased consumption of fish may be beneficial for women at risk for hypertension during pregnancy. A prospective randomized trial of fish or EPA supplementation during pregnancy is warranted.

*From *the Department of Pediatrics, University of Manitoba, Winnipeg, Man., and †the Department of Human Biology, Limburg University, Maastricht, the Netherlands*

‡Dr. Brown is retired from practice in Rankin Inlet, NWT.

Reprint requests to: Dr. Jon M. Gerrard, Manitoba Institute of Cell Biology, 100 Olivia St., Winnipeg, MB R3E 0V9

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Objectif : Évaluer s'il y a un lien possible entre l'incidence d'hypertension au cours de la grossesse et la consommation d'acides gras de poissons et de mammifères marins.
Conception : Enquête rétrospective sur l'hypertension provoquée par la grossesse; enquête prospective sur le régime alimentaire.
Contexte : Femmes inuit de sept communautés de la région du Keewatin, dans les Territoires du Nord-Ouest.
Patientes : Toutes des femmes d'Arviat (anciennement Eskimo Point) et de Baker Lake, Chesterfield Inlet, Coral Harbour, Repulse Bay, Sanikiluaq et Whale Cove qui ont accouché entre le 1er septembre 1984 et le 31 août 1987.
Mesures des résultats principaux : Toutes les mesures de pression artérielle enregistrées au cours de la grossesse, incidence d'hypertension provoquée par la grossesse dans les sept communautés, récolte d'aliments autochtones (tirés de la terre ou de la mer plutôt qu'achetés au magasin) dans six des communautés, consommation avouée de poissons, de mammifères marins et de mammifères terrestres par un sous-groupe de sujets et niveau d'acides gras phospholipidiques dans des échantillons de sérum du cordon chez un sous-groupe de nouveaux-nés.
Résultats principaux : On a constaté une baisse importante de la pression artérielle diastolique moyenne au cours des 6 dernières heures de la grossesse chez les femmes des trois communautés où l'on a consommé plus de poissons et de mammifères marins (78,2 [limites de confiance (LC) à 95 %, 76,6 et 79,9] mm Hg) que celles des quatre communautés où la consommation de ces aliments était plus faible (81,5 [LC à 95 %, 80,1 et 82,9] mm Hg) (p < 0,005). La relation entre le type de régime selon la communauté et la pression artérielle n'avait aucun lien avec d'autres facteurs. Par ailleurs, les femmes des communautés où l'on a consommé moins d'aliments d'origine marine ont été 2,6 fois plus susceptibles de souffrir d'hypertension au cours de la grossesse que celles des communautés où l'on a consommé davantage d'aliments d'origine marine (p < 0,007). On a aussi établi un lien important entre la parité (p < 0,05) et le poids avant la grossesse (p < 0,005), d'une part, et l'hypertension provoquée par la grossesse, de l'autre. Le lien entre l'hypertension et le type de régime alimentaire de la communauté est toutefois demeuré important au cours d'une analyse de régression logistique (rapport des chances 2,56, p = 0,03). Les écarts entre les groupes communautaires ont été étayés par les résultats de l'enquête sur le régime alimentaire, les niveaux d'acide eicosapentanoique (AEP) dans les phospholipides sériques du cordon et les données sur les récoltes.
Conclusions : Une consommation accrue de poisson peut être bénéfique pour les femmes qui risquent d'être victimes d'hypertension au cours de la grossesse. Un essai aléatoire prospectif de consommation de poisson ou d'administration de suppléments d'AEP au cours de la grossesse est justifié.

Gestational hypertension occurs in 6% to 30% of pregnancies.[1,2] The fatty acid composition of the diet may significantly affect the development of this condition.[3] Studies showing increased production of thromboxane, an inducer of platelet aggregation and vasoconstriction, or decreased production of prostacyclin, an inhibitor of platelet aggregation and vasodilation, in pre-eclampsia have suggested that fatty acids and eicosanoate production may be involved in the development of hypertension in pregnancy.[4,5] This hypothesis has been supported by evidence from three recent studies showing that therapy with acetylsalicylic acid, an inhibitor of prostaglandin synthesis, significantly decreases the incidence of hypertension in pregnancy.[6-8]

Changing the diet so that it is rich in sea mammals or fish is an alternative theoretical approach to modifying the production and effects of eicosanoates in order to decrease the incidence of pre-eclampsia.[3,9] Such diets have high levels of eicosapentaenoic acid (EPA) (20:5, n-3), a fatty acid with important antithrombotic potential.[10] (In the nomenclature for fatty acids the figure before the colon indicates the number of carbon atoms, and the figure after the colon the number of double bonds. The notation "n-3" or "n-6" refers to the position of the first double bond from the methyl end of the acyl chain.) EPA competitively inhibits the formation of arachidonate (20:4, n-6) metabolites that induce platelet aggregation, and it can be converted to a prostacyclin, PGI_3, with biologic properties similar to those of PGI_2.[3]

Since fatty acid patterns in the diet, including changes in EPA intake, may affect the blood pressure,[11] we evaluated blood pressure during pregnancy in seven communities in the Northwest Territories, making use of the fact that genetically similar Inuit groups in the Keewatin region have considerably different diets.

Methods

Diet analysis

Twenty-seven Inuit women chosen at random from among those presenting for delivery between July 1, 1985, and Jan. 31, 1986, at the Churchill Health Centre, Churchill, Man., were asked, with the assistance of an Inuit interpreter, to fill out a questionnaire on diet at the time of delivery. Five of the women were from Baker Lake, five from Sanikiluaq, four each from Chesterfield Inlet, Coral Harbour and Repulse Bay, three from Arviat (formerly Eskimo Point) and two from Whale Cove. The questionnaire was designed to take into consideration culture-specific eating patterns and concepts of time. The women were asked to record whether they had eaten fish, seal, caribou, walrus or beef during the past month. Similar questions were asked about the food eaten during the past year. The frequency was scored as follows: not at all, 0 points; occasionally, 1 point; regularly, 2 points; and very often, 3 points.

Additional information on diet was obtained through analysis of the harvest of terrestrial and marine vertebrates for six of the communities.[12,13] In brief, the harvest information was collected as follows. Field workers interviewed hunters in each community once a month and classified them according to whether in the past month they were successful, were unsuccessful, did not hunt, hunted but were not interviewed or did not have a hunt area; some hunters' activities were unknown. The number of animals killed per species was listed for successful hunters who were interviewed. The field workers submitted this information to the project office, where the data were summarized each month against a master list of the hunters in each community and then entered into a computer database. The numbers in some categories were adjusted up to 2 months after a hunting episode if acceptable reports were submitted by field workers for hunters who were missed in the first interview. The project biologist decided whether reports were acceptable by comparing the thoroughness of the information in the late reports with that in the reports submitted on time. Experience in a previous period (1981 to 1983) led to fewer problems with the collection and analysis of the harvest data for the study period analysed (October 1983 to September 1985).

To analyse the harvest data it was assumed that (a) the involvement of hunters whose activities were unknown was the same as that of hunters whose activities were known, (b) the success ratio was the same for hunters whose activities were unknown as for those whose activities were known, (c) in the calculation of the estimated harvest the probability of any individual animal's being killed was the same for all species and (d) reported figures on kills were accurate. The average monthly proportion of hunters reporting was 97% (standard deviation [SD] 1.7%) for Baker Lake, 96% (SD 5.3%) for Chesterfield Inlet, 93% (SD 5.7%) for Arviat, 73% (SD 31%) for Whale Cove, 69% (SD 24%) for Coral Harbour and 65% (SD 10%) for Repulse Bay. We compared the harvest information with the 1985 population estimate for each community[14] to estimate the harvest per person. Since a much lower proportion of the whale carcass than of other country foods (food obtained from the land or sea rather than bought in a store) is actually consumed we divided the harvest of whales by three for analysis.

On the basis of the harvest data Coral Harbour and Repulse Bay were classified as having a higher consumption of fish and sea mammals (Table 1). Although specific harvest data were not available for Sanikiluaq, located on the Belcher Islands, the people in this community have virtually no terrestrial mammals in their diet. The remaining four commu-

Table 1: Harvest of terrestrial mammals and of sea mammals and fish by Inuit hunters from six communities in the Keewatin region of the Northwest Territories from October 1983 to September 1985*

	Per capita harvest, kg				
Community	Terrestrial mammals	Sea mammals (excluding whales) and fish	Whales	All marine food†	All country food
Arviat	213	41	64	62	275
Baker Lake	637	20	0	20	657
Chesterfield Inlet	126	48	97	80	206
Coral Harbour	124	99	246	181	305
Repulse Bay	340	132	103	166	506
Whale Cove	321	87	107	123	444

*Based on Gamble's data.[12,13]
†Since a much lower proportion of the whale carcass than of other country foods (food obtained from the land or sea rather than bought in a store) is actually consumed the harvest of whales was divided by three.

nities were classified as having a lower consumption of marine food.

Analysis of phospholipid fatty acids in cord serum

Cord serum samples were obtained from 16 infants of Inuit women from the seven communities who gave birth between July 1, 1985, and Jan. 31, 1986. The samples were warmed to room temperature and the lipids extracted according to the procedure of Bligh and Dyer.[15] Total phospholipids were isolated by means of thin-layer chromatography.[16] The phospholipids were hydrolysed and the resulting fatty acids methylated with boron trifluoride.[17] Fatty acid methyl esters were analysed by means of gas-liquid chromatography.[18] Using computer-assisted analysis we corrected the fatty acid profiles for blank runs (one in each series of six samples), in which saline was substituted for plasma in the extraction procedure, and adjusted them with respect to the internal standard, the methyl ester of 15:0. The results were expressed as area percentage of total fatty acids. To prevent oxidation of the polyunsaturated fatty acids the antioxidant butylated hydroxytoluene, 0.05% weight per volume (Sigma Chemical Company, St. Louis), was added to all organic solvents.

Collection of blood pressure data

The charts of all 300 Inuit women from the seven communities who gave birth between Sept. 1, 1984, and Aug. 31, 1987, were reviewed, and the following information was extracted: all blood pressure readings during the pregnancy, age, height, weight before pregnancy and at term, smoking habits, number of previous pregnancies, parity, community, presence of proteinuria, any medications given for high blood pressure and whether bed rest had been prescribed; the infant's birth weight, sex and gestational age were also noted. The blood pressure was usually recorded at the local nursing station during the first 8 months of pregnancy and in Churchill or Winnipeg during the last 2 to 4 weeks of pregnancy. For each woman we calculated the mean of all blood pressure measurements (usually 6 to 30) taken during the last 6 hours of pregnancy, including those obtained during labour. Hypertension was considered to be present when two or more diastolic blood pressure (DBP) readings greater than 90 mm Hg taken at least 6 hours apart were recorded.[19]

Statistical analysis

We analysed differences between communities of different diet types using an unpaired *t*-test. Multiple regression[20] and logistic regression[21] analyses were used to assess whether the association between community diet type and DBP or hypertension at the end of pregnancy was independent of other factors. We analysed the association between blood pressure and the levels of phospholipid fatty acids in cord serum samples by means of linear regression. Residuals were examined for all reported regressions; in each case the residuals were random, and they neither were skewed nor displayed any specific patterns.

Results

Diet

Analysis of the diet of the 27 Inuit women showed that those from communities with a higher consumption of marine food reported consuming significantly more fish and sea mammals and less caribou than those from communities with a lower

Table 2: Frequency of consumption of fish and sea mammals and of caribou by 13 Inuit women from communities with a higher consumption of marine food and 14 from communities with a lower consumption of marine food*

Food consumed	Mean score (and 95% CL†): Communities with higher consumption	Mean score (and 95% CL†): Communities with lower consumption	*p* value‡
Marine food			
Past month	2.61 (1.37, 3.85)	1.38 (0.82, 1.94)	NS
Past year	3.77 (2.64, 4.90)	2.31 (1.32, 3.30)	0.046
Average	3.19 (2.08, 4.30)	1.85 (1.11, 2.58)	0.039
Caribou			
Past month	1.15 (0.41, 1.89)	2.00 (1.35, 2.65)	NS
Past year	1.46 (0.57, 2.35)	2.40 (1.82, 2.98)	0.024
Average	1.31 (0.76, 1.94)	2.20 (1.64, 2.76)	0.034

*The frequency ranged from not at all (0 points) to very often (3 points).
†CL = confidence limits.
‡NS = not significant.

consumption of marine food (Table 2). Since our questionnaire was deliberately as simple and as culturally appropriate as possible it was important to confirm this impression. Analysis of the levels of phospholipid fatty acids in cord serum showed that the samples from infants of women from communities with a higher marine food consumption contained greater amounts of EPA and docosahexaenoic acid and a higher ratio of 22:6 (n-3) to 22:5 (n-6) fatty acids than the samples from infants of women from communities with a lower consumption of such food (Table 3). (This ratio is used because the 22:5 [n-6] level tends to be higher with lower 22:6 [n-3] levels, and 22:5 [n-6] may be synthesized to compensate for decreased amounts of 22:6 [n-3].[22]) Levels of the mead acid (20:3 [n-9]), usually considered a marker of essential fatty acid deficiency,[23] were higher among the infants of women from communities with a lower consumption of marine food. Increased mead acid levels were correlated with a decreased ratio of 22:6 (n-3) to 22:5 (n-6) fatty acids ($r = 0.63$, $p = 0.007$).

Blood pressure

Of the 300 women whose charts were reviewed 111 were from communities with a higher consumption of marine food and 189 were from those with a lower consumption of such food. A total of 38% of the former group and 40% of the latter group gave birth in Winnipeg; the remaining women gave birth in Churchill (Table 4).

The mean DBP at the end of pregnancy was significantly lower among the women from communities with a higher marine food consumption than among those from communities with a lower consumption of such food ($p < 0.005$) (Table 5). The mean DBP during the last 6 hours before delivery was consistently higher among the women from the four communities with a lower marine food consumption (Arviat 82.1 [95% confidence limits (CL) 80.1 and 82.1] mm Hg, Baker Lake 80.5 [95% CL 77.9 and 83.1] mm Hg, Chesterfield Inlet 81.9 [95% CL 76.5 and 87.3] mm Hg and Whale Cove 81.1 [95% CL 76.3 and 85.9] mm Hg) than among those

Table 3: Levels of phospholipid fatty acids in the cord serum of nine infants of women from communities with a higher consumption of marine food and seven infants of women from communities with a lower consumption of marine food

	Mean area % of fatty acids (and 95% CL)		
Variable	Communities with higher consumption	Communities with lower consumption	*p* value
Phospholipid fatty acid			
20:3 (n-9)	1.33 (1.12, 1.54)	1.90 (1.24, 2.56)	NS
20:4 (n-6)	11.17 (9.81, 12.53)	11.18 (8.19, 14.17)	NS
20:5 (n-3)	0.73 (0.38, 1.08)	0.25 (0.18, 0.32)	0.01
22:5 (n-6)	0.77 (0.70, 0.84)	1.07 (0.87, 1.27)	NS
22:6 (n-3)	5.02 (3.98, 6.06)	3.56 (1.97, 5.15)	NS
Ratio of 22:6 (n-3) to 22:5 (n-6)	6.66 (5.02, 8.30)	3.38 (2.08, 4.68)	0.03

Table 4: Number of births in Winnipeg and in Churchill for each community

	Place of delivery; no. of births		
Community	Winnipeg	Churchill	Total
Higher marine food consumption			
Coral Harbour	11	29	
Repulse Bay	19	19	
Sanikiluaq	12	21	
Total	42	69	111
Lower marine food consumption			
Arviat	37	52	
Baker Lake	24	32	
Chesterfield Inlet	7	17	
Whale Cove	8	12	
Total	76	113	189

from the three communities with a higher marine food consumption (Coral Harbour 79.0 [95% CL 76.4 and 81.6] mm Hg, Repulse Bay 77.3 [95% CL 74.5 and 80.1] mm Hg and Sanikiluaq 78.2 [95% CL 75.1 and 81.3] mm Hg). The differences between the two community groups in mean DBP at the end of pregnancy were not due to differences in the proportion of primiparous to multiparous women, since 47 (25%) of the women from communities with a lower consumption of marine food and 23 (21%) of those from communities with a higher consumption of such food were primiparous. Indeed, the same differences remained when the data for the primiparous and multiparous women were analysed separately: the mean DBP values during the last 6 hours of pregnancy for the primiparous women were 83.0 (95% CL 80.4 and 85.6) mm Hg for those from communities with a lower marine food consumption and 79.7 (95% CL 76.8 and 82.6) mm Hg for those from communities with a higher marine food consumption, and for the multiparous women 80.9 (95% CL 79.3 and 82.5) mm Hg and 77.8 (95% CL 76.0 and 79.6) mm Hg respectively.

We evaluated other factors that have been shown to be associated with pregnancy-induced hypertension[1,2,24] and that may have been responsible for the observed association. We found a significant difference between the two community groups in mean prepregnancy weight and mean maternal weight at term ($p < 0.005$) (Table 6). Multiple regression analysis showed that the systolic blood pressure (SBP) during the last 6 hours of pregnancy was significantly associated with parity ($p < 0.005$) and with the maternal weight at term ($p < 0.005$), according to the following relation: SBP = 106.7 + (6.73 × primiparous status) + (0.24 × term weight in kilograms) ($r^2 = 0.10$).[20] Multiple regression analysis also showed that the DBP during the last 6 hours of pregnancy was significantly associated with the prepregnancy weight ($p < 0.05$) and community diet type ($p < 0.05$), according to the following relation: DBP = 71.2 + (2.76 × diet type) + (0.127 × prepregnancy weight in kilograms) ($r^2 = 0.05$).

Hypertension was diagnosed in 53 (18%) of the 300 women, 41 (22%) from communities with a lower consumption of marine food and 12 (11%)

Table 5: Mean blood pressure values from 20 weeks of pregnancy to delivery for the 111 women from communities with a higher consumption of marine food and the 189 women from communities with a lower consumption of marine food

Time; pressure	Mean blood pressure (and standard deviation [SD]), mm Hg		p value
	Communities with higher consumption	Communities with lower consumption	
Week 20	(n = 84)	(n = 139)	
Systolic	104.8 (10.1)	105.7 (10.6)	NS
Diastolic	59.3 (6.4)	62.5 (8.2)	< 0.05
Week 30	(n = 90)	(n = 147)	
Systolic	107.2 (19.9)	108.0 (25.5)	NS
Diastolic	61.9 (16.1)	63.2 (20.4)	NS
Week 35	(n = 90)	(n = 154)	
Systolic	109.5 (11.4)	111.6 (13.6)	NS
Diastolic	66.4 (9.5)	68.8 (10.9)	NS*
Week 36	(n = 63)	(n = 112)	
Systolic	111.9 (11.1)	113.2 (12.7)	NS
Diastolic	68.6 (9.5)	71.4 (10.6)	NS*
Week 37	(n = 58)	(n = 113)	
Systolic	114.3 (12.9)	116.6 (15.9)	NS
Diastolic	70.6 (9.1)	73.4 (12.7)	NS
Week 38	(n = 55)	(n = 102)	
Systolic	120.5 (11.1)	120.7 (15.0)	NS
Diastolic	76.5 (11.1)	77.4 (13.0)	NS
Week 39	(n = 40)	(n = 51)	
Systolic	119.4 (10.1)	123.5 (12.1)	NS*
Diastolic	76.6 (10.7)	80.0 (11.4)	NS*
Week 40	(n = 10)	(n = 24)	
Systolic	104.9 (34.1)	125.5 (16.2)	< 0.05
Diastolic	74.6 (10.4)	82.0 (12.3)	NS*
Last 6 h before delivery	(n = 107)	(n = 182)	
Systolic	122.7 (9.27)	125.5 (14.9)	NS*
Diastolic	78.2 (8.24)	81.5 (9.5)	< 0.005

*0.1 > f > 0.05.

from communities with a higher consumption of such food (Table 7). Analysis of the data showed that women from the former communities were 2.6 (95% CL 1.28 and 5.29) times more likely to become hypertensive during pregnancy than women from the latter communities ($p < 0.007$).[21] All 41 women from communities with a lower marine food consumption in whom hypertension was diagnosed were treated with bed rest, antihypertensive drugs or both, as compared with 9 of the 12 women from communities with a higher marine food consumption.

Because prepregnancy weight may have been a confounding factor (Table 6), logistic regression was done; it showed that there were four independent predictors of pregnancy-induced hypertension:[20] prepregnancy weight ($p < 0.005$), parity ($p < 0.05$), place of delivery ($p < 0.01$) and community diet type ($p < 0.05$). For prepregnancy weight the odds ratio was 1.06 (95% CL 1.03 and 1.09) per kilogram of weight, for parity the odds ratio was 2.59 (95% CL 1.37 and 4.86) for being primiparous versus being multiparous, and for place of delivery the odds ratio was 2.36 (95% CL 2.17 and 4.31) for Winnipeg versus Churchill. The development of pregnancy-induced hypertension was not associated with smoking, maternal age, baby's birth weight or gestational age. After the other variables were adjusted for, the odds ratio for community diet type was 2.56 (95%

Table 6: Features known to be associated with pregnancy-induced hypertension in the two community groups[1,2,24]

Feature	Communities with higher consumption (n = 111)	Communities with lower consumption (n = 189)	p value
No. (and %) of primiparous women	23 (21)	47 (25)	NS
No. (and %) of smokers	93 (84)	144 (76)	NS
Mean weight before pregnancy (and SD), kg	55.4 (10.5)	59.1 (11.0)	< 0.005
Mean weight at term (and SD), kg	64.9 (12.6)	69.3 (2.2)	< 0.005
Mean maternal age (and SD), yr	23.4 (6.3)	23.9 (5.5)	NS
Mean maternal height (and SD), cm	152.1 (8.4)	154.5 (6.9)	NS
Mean weight of infants (and SD), g	3371.6 (550)	3438.8 (604)	NS
Mean gestational age (and SD), wk	39.0 (2.1)	38.9 (1.4)	NS

Table 7: Number of women in the two community groups in whom hypertension was diagnosed or for whom bed rest or antihypertensive drugs or both were prescribed

	No. (and %) of women					
	Communities with higher consumption; place of delivery			Communities with lower consumption; place of delivery		
Variable	Winnipeg	Churchill	Total	Winnipeg	Churchill	Total
Hypertension diagnosed by attending physician	9	3	12 (11)	24	17	41 (22)
Diastolic blood pressure greater than 90 mm Hg on two occasions at least 6 hours apart	9	2	11 (10)	24	14	38 (20)
Proteinuria present	3	0	3 (3)	8	3	11 (6)
Antihypertensive drugs prescribed	2	0	2 (2)	7	2	9 (5)
Bed rest prescribed because of hypertension	4	0	4 (4)	15	9	24 (13)
Both bed rest and antihypertensive drugs prescribed	2	1	3 (3)	8	2	10 (5)
Any of above six variables present	9	3	12 (11)	24	17	41 (22)

CL 1.17 and 5.57) for lower versus higher marine food consumption. Therefore, community diet type remained a significant independent variable.

The DBP during the last 6 hours of pregnancy was significantly associated with the levels of EPA and 22:5 (n-6) fatty acids in cord serum, according to the following relations: (a) DBP = 89.5 − 14.3 EPA (r^2 = 0.27, p = 0.04) and (b) DBP = 54.7 + 30.5 22:5 (n-6) (r^2 = 0.33, p = 0.02).

Regression analysis showed that the relation between the marine harvest (MH) (all sea mammals and fish) (Table 1) and the mean DBP during the last 6 hours of pregnancy (DBP = 82.5 − 0.021 MH) was not significant (p = 0.12). Changing the regression equation to factor in the terrestrial mammal harvest (TH), at a lower proportion (1/4) than fish and sea mammals, gave the regression equation DBP = 85.7 − 0.03 (MH + 1/4 TH), which was highly significant (r^2 = 0.80, p = 0.015) (Fig. 1).

Discussion

We found a significantly lower mean DBP during the last 6 hours of pregnancy for the women from communities with a higher marine food consumption than for those from communities with a lower consumption of such food. The differences cannot be accounted for by differences in the technique of measuring blood pressure since similar proportions of patients from the seven communities were seen at the two hospitals involved and since the differences in blood pressure were evident regardless of the place of delivery. Furthermore, the difference

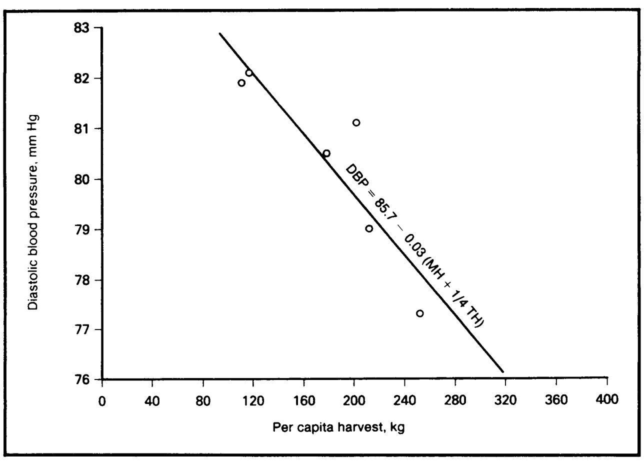

Fig. 1: Relation between mean diastolic blood pressure (DBP) during last 6 hours of pregnancy for Inuit women from six communities in Keewatin region of Northwest Territories and harvest of country food (food obtained from land or sea rather than from a store) from October 1983 to September 1985 for each community. MH = marine harvest, TH = terrestrial mammal harvest (see Table 1).

between the two community groups was not due to treatment, since more of the women from communities with a lower consumption of marine food were treated.

The magnitude of the differences in blood pressure between the two community groups was small. The clinical significance of the individual differences is that in so far as the mean blood pressure during the last 6 hours of pregnancy is higher for women from a given community, an increased proportion of women from that community will likely present with pregnancy-induced hypertension. This was indeed the case in our study.

The incidence rate of pregnancy-induced hypertension among the Inuit women in our study, 18%, correlates with the rate among white women.[1] Thus, there is no indication that the Inuit as a group have a lower incidence of hypertension than the rest of the population. The relative odds of the development of hypertension in women from communities with a lower marine food consumption versus those from communities with a higher consumption of such food (2.56) may understate the relative odds for an individual woman. We did not assess the range of dietary intake within a community. Some women from communities with a higher consumption of fish and sea mammals may have had a diet low in such food, which would give a misclassification bias that would tend to cause the reported relative odds to underestimate the true relative odds.

Potential confounding variables cannot explain the observed differences. For both community groups there was a significant increase in mean blood pressure during the last 6 hours of pregnancy among women who gave birth in Winnipeg. This increase is probably explained by the considerable number of women at high risk transported to Winnipeg. Parity and prepregnancy weight, factors known to be associated with pregnancy-induced hypertension,[1,2,24] were found to be valid predictors of hypertension, but neither could explain the differences between the community groups, although women from communities with a higher consumption of marine food did have a significantly lower prepregnancy weight than women from communities with a lower consumption of such food.

One possible explanation for the differences in blood pressure is genetic variation.[25] The communities are genetically very similar, with the possible exception of Coral Harbour, where there was considerable intermarriage between early whalers and Inuit dwellers of the region. Since the blood pressure values for Coral Harbour were similar to those for Repulse Bay and Sanikiluaq and lower than those for the communities with a lower consumption of marine food this factor is unlikely to account for the observed differences.

The most probable explanation for the differences in blood pressure is diet. Coral Harbour, Repulse Bay and Sanikiluaq are located away from major caribou migration routes and are situated in areas where sea mammals and fish are readily available, on the shores of Hudson Bay. Baker Lake is situated on a major caribou migration route, and the people in this community eat caribou rather than fish. Three of the communities with a lower consumption of marine food (Arviat, Chesterfield Inlet and Whale Cove) are on Hudson Bay, but the residents eat less fish and sea mammals and more caribou or Western food. The diet survey and measurement of phospholipid levels in the cord serum of newborns substantiated this difference.

Some caution, however, must be exercised in relating the differences in blood pressure exclusively or even primarily to fish and sea mammals in the diet. There has been a gradual Westernization of the diets of all the Inuit groups. It has been argued that this change increases the rates of cardiovascular disorders in such communities.[26] The observed differences in blood pressure may be related to differences in salt intake and other factors.[24] Indeed, regression analysis of the relation between DBP and community diet type showed that the relation was significant only when the caribou harvest was factored in. This suggests that the differences between the community groups in mean DBP during the last 6 hours of pregnancy may be explained partly by consumption of fish and sea mammals and partly by varying proportions of food other than country food in the diet. However, if Sanikiluaq is included in the analysis, with an estimated per capita harvest of marine food of 185 to 235 kg over the 2-year period (a reasonable range, given the knowledge of this community), the regression of harvest of marine food versus mean blood pressure during the last 6 hours of pregnancy for each community would achieve significance at a p value of less than 0.05.

Our findings are consistent with the concept that there is a relation between blood pressure during pregnancy and the type of fat in the diet.[1] A diet rich in fish and sea mammals will have an abundance of n-3 polyunsaturated fatty acids. Arachidonic acid, the precursor of dienoic prostanoids, is mainly derived from fatty acids found in meat and will be partly replaced by EPA.[27] EPA may decrease the incidence of hypertension by reducing platelet aggregation and adhesion and altering the balance of vasoactive eicosanoates.[28]

Our results parallel findings from other studies showing that dietary supplementation with n-3 polyunsaturated fatty acids lowers the blood pressure in patients with mild essential hypertension.[29,30] Knapp and Fitzgerald[30] showed that fish oil at dosages providing 9.0 g of EPA daily was effective, but fish oil at dosages providing only 1.8 g of EPA daily was not. We did not measure the levels of total dietary EPA in our subjects and cannot provide an accurate estimate for daily EPA intake. A crude calculation based on existing analysis of the fatty acid content of foods from this region[31,32] suggests that residents of the communities with a higher consumption of marine food may have a mean daily intake of n-3 polyunsaturated fatty acids of 2.4 to 4.5 g. The low proportion of EPA in the cord serum samples in our study is due to the fact that cord serum EPA levels are much lower than maternal serum EPA levels. Indeed, the mean proportions of EPA in the phospholipid fatty acids in the serum of adults in six of the communities (Arviat 1.2% [n = 32], Baker Lake 0.6% [n = 15], Chesterfield Inlet 1.5% [n = 16], Coral Harbour 3.5% [n = 16], Repulse Bay 3.9% [n = 16] and Sanikiluaq 3.8% [n = 16] [J.M.G.: unpublished data]) were much higher than those for newborns (Table 3). Also, the proportions of EPA for the adults further confirm our assignment of the communities according to marine food intake.

The fact that the largest differences in blood pressure between the community groups were found during the last 6 hours of pregnancy may be due in part to sample size but may also suggest that the stress of pregnancy produces such differences. The results are consistent with evidence relating the increased incidence of pre-eclampsia at the end of pregnancy to the production of vasoactive eicosanoates derived from polyunsaturated fatty acids,[31,33] given that eicosanoates tend to be more important modulators of physiologic events during stress or injury than under strictly basal conditions. Further study is needed to fully explain the reasons for the differences in blood pressure. However, our results suggest that diet modification may decrease the risk of hypertension during pregnancy. Since there may be differences between the communities in other factors that we did not measure (i.e., salt intake) a prospective trial of fish or EPA supplementation during pregnancy is needed to establish whether increased consumption of fatty acids derived from fish helps prevent pregnancy-induced hypertension.

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